DOCUMENT RESUME

ED 170 124 SE 027 540

TITLE	Energy Conservation Workshop - Training Requirements for Technicians (Atlanta, Georgia, October 30-November 1, 1977).
INSTITUTION	Department of Energy, Washington, D.C. Div. of Power Systems.
PUB DATE	Mar 78
NOTE	54p.; Contains occasional light type
AVAILABLE FROM	National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161 ($5.25)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	Community Colleges; Energy; *Energy Conservation; *Fuel Consumption; *Higher Education; Postsecondary Education; Socioeconomic Influences; *Technical Education; Technological Advancement; *Technology Transfer; *Vocational Education; Workshops

ABSTRACT

This workshop was convened to study the training requirements of skilled technicians who will be required to install, operate, and maintain the advanced equipment and systems being developed by the Division of Power Systems of the Department of Energy (DOE). Community college educators and DOE technology program administrators were brought together in a workshop setting for discussions on the status of current programs, future needs, and ways needs could be solved. Included in the document are sections containing conclusions and recommendations of the conference, background of the conference, and a conference report. Appendices include a list of workshop participants, a description of the DOE's Division of Power Systems, and a brief summary of some of the characteristics of the junior college and community college system. (RH)

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CONF-7710118

ED170124

ENERGY CONSERVATION WORKSHOP - Training Requirements for Technicians

October 30-November 1, 1977
Atlanta, Georgia

Sponsored By
U.S. DEPARTMENT OF ENERGY
Assistant Secretary for Energy Technology
Division of Power Systems

March 1978

SE 027 540

Available from:

National Technical Information Service (NTIS)
U. S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161

Price: Printed Copy: $5.25
Microfiche : $ 3.00

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FOREWORD

The strategy needed to meet national energy objectives and resolve the nation's energy problems require the introduction of new and advanced technologies that will use energy more efficiently and tap more plentiful resources. However, resolving the nation's energy problems can be realized only through a combined effort of the public and private sectors. Innovative energy technologies not only must be researched, developed, and demonstrated, but must be introduced into the marketplace as rapidly as possible. Rapid market introduction depends on people and the millions of energy-related decisions made by corporations, businesses, public institutions, communities, and homeowners.

The nation's energy program, although equally important, is distinctly different from earlier government undertakings such as the Manhattan Project or the space program. The Department of Energy (DOE) will be neither the buyer nor seller of technology but will serve as a catalyst for ensuring that adequate technological options are commercially available to the public.

In response to this unique federal role, the Division of Power Systems (DPS) has embarked on innovative interactive planning experiments. Technological solutions in themselves are not sufficient response to national energy issues. Socio-economic and institutional ramifications of any technological innovation must be considered to ensure their success in the commercial marketplace. Clearly, skilled technicians will be required to install, operate, and maintain the advanced equipment and systems being developed by DPS. The workshop summarized in this report was convened specifically to study the training requirements for these technicians.

We brought together community college educators and DOE technology program administrators in an interactive workshop setting conducive to candid and focused discussions. But our efforts to involve a broad range of perspectives in our planning require continuous feedback from the public. As a reader of this report, you become an integral part of our interactive planning experiment, and I invite you to participate by sending us your reactions and comments.

Dominic J. Monetta

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CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. A small number of curricula, one and two years in length, were identified in the planning stages. These were aimed at producing "energy technicians." The workshop group was skeptical about the present labor market demand for such persons and the efficacy of many educational institutions duplicating such efforts at this time. A major factor in their skepticism was the difficulty of defining a set of educational criteria for an "energy technician" who would be a marketable generalist.

   The group recognized that unless coordination takes place, various noncoordinated federal and state agencies must fund numerous curricula projects. Manpower assessment tasks and a comprehensive study of performance and competing criteria for technicians working in the energy fields should be undertaken in a coordinated fashion.

   Presently it is very difficult for colleges contemplating new energy technology programs to integrate existing national energy data or manpower data into their regional assessment. Neither is it possible to identify persons or an institution to help translate the Department of Energy policy on national data collected by federal agencies into a format useful to colleges.

2. The group concluded that efforts should be increased to add energy conservation concepts to current engineering-based technician curricula being offered at community colleges and universities. The

engineering technician should learn not only methods, but also the reasons for conserving energy. Efforts to accomplish this could range from modification of a course syllabus all the way to development of "new" courses in energy conservation. Developing an inventory of current practices and sponsoring "new" course development represent tasks which the Department of Energy might finance.

3. An important need appears to exist for developing a well-managed and timely clearinghouse for the dissemination of information on activities in energy-related curricula, courses, and projects existing or emerging from the community colleges and universities. A similar source is needed for announcing Department of Energy priorities, program announcements, etc. The already evident proliferation of "energy news" adds to the urgency for a single outstanding clearinghouse publication. The group thought that the "Energy and Education Newsletter," distributed by the National Science Teachers Association (NSTA), might be expanded into such a publication with support from the Department of Energy.

4. The group concluded that the Department of Energy program divisions responsible for pilot and demonstration projects should be encouraged to address the training dimensions of their projects in conjunction with evaluating the technical aspects.

5. The group strongly endorsed the conclusion that it is imperative for community colleges to develop even stronger relationships with the industrial and business communities that they geographically serve. These relationships should be established before programs are developed. A wide variety of energy

education projects that could be highly beneficial to the Department of Energy's goals and objectives would seem to be most efficiently and effectively discharged through close, careful planning and proper development between community colleges and their respective industrial/business base.

6. The Doggette Report should be updated and expanded to include projects in continuing education.

7. The Energy Extension Service concept continues to represent one of the most critical projects the Department of Energy is undertaking and has enormous educational implications for the nation's community colleges.

8. Many of the demands which energy education dictates lead to the need for cooperative arrangements by colleges and universities in order to optimize Department of Energy expenditures as well as those by the institutions themselves. This is particularly true with "two plus two" curricula development.

9. More efforts should be directed towards integrating high quality energy-related topics and fundamentals into college courses like physics, chemistry, and biology at all levels of education.

10. Great potential seems to exist for the utilization of teaching modules which the Department of Energy could collect (or have developed) in a broad spectrum of energy-related topics. This seems to represent one of the best techniques for achieving replication and leverage for a modest fund outlay by the Department of Energy.

11. The American Association for Community and Junior Colleges (AACJC), possibly through its Council for Occupational Education, represents the most broadly based organization with whom the Department of Energy should interface for community college input and project development.

12. The utilization of the community colleges as the primary vehicle for whatever "citizen education" the Department of Energy eventually encourages or sponsors is worth reemphasizing. Community colleges must individually recognize that they are only one of many existing delivery systems for energy education and information. They must remain viable and responsive to the energy needs of their communities if they expect to remain a primary delivery system.

Recommendations

1. If it is not presently being done, the Department of Energy should sponsor an analysis of competency needs for (and criteria to measure the performance of) technicians to be proficient in both general and specific areas of energy conservation. Depending on the local labor market demand, individual colleges could implement programs or add courses.

2. The Assistant Secretary for Intergovernmental and Institutional Relations should translate data pertaining to energy-related occupations into a format which will be valuable to colleges planning curricula directed towards those occupations. If possible, the Secretary should develop the capacity to respond to individual colleges requiring planning information on labor markets for energy personnel

and curricula for energy occupations. Existing models, including those developed by the Environmental Protection Agency and other organizations, should be reviewed as possible starting points.

3. Community colleges with engineering-based degree technician curricula should add energy conservation dimensions to the programs. Methods for encouraging this should be worked out between the Department of Energy and the AACJC's Council of Occupational Education (or a similar entity).

4. The AACJC and other similar organizations should develop a system to systematically feed information related to energy developments in the community college system into the "Energy and Education Newsletter."

5. The Department of Energy should use the "Energy and Education Newsletter" as one of their primary vehicles for providing pertinent information to the higher education community.

6. The Council of Occupational Education, with support from the Department of Energy, should consider a subsection for energy education primarily as a mechanism for a central focus on energy education curricula development.

7. Given that certain community colleges already have implemented energy conservation and solar technology programs, careful attention should be given to the eventual placement of their graduates. Existing and future energy programs should be evaluated on the success of the community colleges in placing their graduates in training-related occupations

rather than on the title or other trappings which are frequently used to dress-up program offerings in new areas.

8. The Department of Energy should establish an information retrieval system for various categories of users (i.e., instructors in energy conservation, equipment maintenance research).

9. The planning and budgeting documentation that the Department of Energy requires of its technical pilot and demonstration grant managers should include a section on "training ramifications." In preparing this section, the managers should address questions related to the technician (and other) training which might be required or planned should the projects meet their milestones successfully.

10. Techniques should be established that overtly encourage community colleges and their respective local industrial/business communities to work together on the development of energy education projects which would respond to identified needs. This seems to be important enough to justify a conference involving the Department of Energy, community college leaders, and industrial association representatives.

11. The Department of Energy should finance an update of the Doggette Report expanded to include projects in continuing education.

12. The AACJC should encourage community colleges to "link in" to their respective state plans related to the Energy Extension Service concept.

13. The Department of Energy, in its request for proposals (RFP's) related to education, should provide weight to proposals involving cooperative arrangements between institutions of higher education.

14. The Department of Energy should consider projects which specifically encourage the integration of energy-related topics and fundamentals into "regular" college courses like physics, chemistry, and biology.

15. The Department of Energy should work with appropriate community college advisory groups to develop RFP's which would address the development of educational modules specifically oriented to:
    (a) Identified industrial training needs, and
    (b) Specialized energy education courses which could be "added to" current curricula.

16. The Department of Energy should review comparable efforts on module development in the environmental field in order to profit from these efforts.

17. The Department of Energy should identify and coordinate with other federal and state agencies that are also funding and providing energy-related materials developed by the Department of Energy and other agencies to educational institutions.

BACKGROUND

The "Second Atlanta Conference" was convened on October 30, 1977, in direct response to a recommendation from the "Energy Conservation Workshop for Community College Leaders" held in Chicago in November, 1976.

The recommendation of the Chicago conference was that "The Office of Conservation should sponsor a workshop (or workshops) in which selected community college technical curricula experts can study in-depth the specific long-range, technician-level needs which programs sponsored by the Office of Conservation will create. These workshops should involve industrial representatives and should carefully look at alternative delivery systems, cooperative educational strategies, replicable units of instruction and training, as well as the traditional two-year curricula models."

Participants in the "Second Atlanta Conference" included educators and energy technology managers from the Department of Energy. A dozen community college and university professionals who had experiences in occupational curricula development were selected. The Department of Energy professionals were primarily project management-level engineers and scientists. A list of the conference participants is shown in Appendix A.

Since a major reorganization had just occurred, creating the Department of Energy out of the Energy Research and Development Administration and other energy-related units within the federal government, a majority of the Department of Energy participants were from, or related to, the Division of Power Systems. Therefore,

the primary mission and objectives of the Division of Power Systems are germane and are outlined in Appendix B.*

A main premise underlying the conference was that the community college system is in an excellent position to be of technical assistance to the Department of Energy in two areas of their expertise:

(1) The development and discharge of occupational programs designed to train personnel for technician positions which will emerge from the forming governmental/industrial energy complex; and

(2) The development and discharge of specialized courses, workshops, or seminars related to citizen education within communities. This also applies to the development of training units for small businesses and industries within the territorial prerogatives of the more than 1,000 national community colleges.

A description of the community college system is given in Appendix C.

The national association which speaks for the two-year college system is the American Association of Community and Junior Colleges (AACJC). Representing this association at the "Second Atlanta Conference" was Dr. Andrew Korim of the AACJC's Council for Occupational Education.

The Conference Coordinator was METRICS, INC., an Atlanta-based scientific consulting firm.

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*As this document was being prepared, the Division of Power Systems had not been formally approved. However, the functions of the Division are expected to be fulfilled regardless of the organization's name.

CONFERENCE REPORT

Opening Session

The eighteen Workshop participants met originally as a total group. Since information on the general community college system had been distributed in advance, the session began with each community college participant discussing the individual differences of his particular role and that of his institution.

Following that discussion, the Department of Energy participants explained their functional areas of concern. Mr. Dominic J. Monetta elaborated on the recently implemented reorganization which placed the Department of Energy in operation, replacing, for the most part, the Energy Research and Development Administration (ERDA) and the Federal Energy Administration (FEA).

A number of discussion topics were analyzed by the entire group, including the following:

(1) What effect will the "new" Department of Energy have on policies concerning training and educational activities related to energy conservation?

(2) Will there be any change of focus in energy-related areas because of the reorganization?

(3) Will it be harder or easier for the educational community to interface with the Department of Energy as compared to the Energy Research and Development Administration?

Group Organization

Following the general discussion, the Workshop was divided into two groups:

Group I. Formal Curricula and Courses

Dr. Arden Pratt, Chairman
Mr. Dominic J. Monetta
Dr. John H. Austin
Mr. Jerry Duane
Dr. Andrew S. Korim
Dr. Sabra Meservey
Mr. Carl Schwing
Mr. Michael D. Shapiro
Mr. James Zapatka

Group II: Continuing Education

Dr. J. N. Carsey, Chairman
Dr. John Doggette
Dr. Walter O. Carlson
Mr. Robert H. Dempsey
Mr. Donald Duggan
Dr. Robert Illingsworth
Dr. Stephen Rasmussen
Mr. Matthew J. Rosso
Mr. Martin Zlotnick

Discussion questions designed to serve as directional indicators for each group's discussions were distributed. The discussion questions for each group were as follows:

Group I: Formal Curricula and Courses

1. Discuss the options available (and develop others) for energy-related training starting with:
   (a) Formal degree curricula
   (b) Special courses added to existing curricula
   (c) Special workshops for in-service
   (d) Specialized courses for industry
2. Does there seem to be any justification for the development of a curriculum in energy technology?
3. Is it possible to identify manpower needs in energy-related fields? Has it been done?
4. Do any of the energy-related fields lend themselves to "two plus two" programs or any variation thereof?
5. Should the Department of Energy encourage the development of model curricula and/or courses?
6. Does energy-related education lend itself to "ladder" training?

7. What role can the University Staff Group in the Department of Energy play in any future projects? Other Divisions in the Department of Energy?
8. Should there be advisory groups or task forces working in this area?

Group II: Continuing Education

1. What type of consumer education training seems most appropriate?
2. Is there a need for variety in teacher education training for energy conservation?
3. Should courses be developed centrally with the Department of Energy's support or at random in colleges around the country?
4. Courses? ..... What does that mean? Can you properly differentiate between "formal" or "regular" courses and "continuing education" courses?
5. What seems to be the proper role for the Department of Energy in this area? For other organizations? Is there need for a separate structure?

Group I: Formal Curricula and Courses. Group I concentrated on discussing and analyzing the proper role and directions which the community college systems and the Department of Energy should pursue in the development of energy-related curricula and courses. The curricula under discussion was directed towards the development of "Technicians or Technologists" in the energy conservation field. The course development discussed were courses which directly related to the training of such technicians.

An extremely broad range of topics was thoroughly discussed by Group I, and the conclusions and recommendations of that group's deliberations are reflected in that section.

Group II: Continuing Education. Group II concentrated on the area of training which has become known as "continuing education." This area includes courses, workshops,

seminars, lectures, and special events which are not ordinarily directed towards a career objective or an academic degree. These types of projects could range from consumer education courses to specific energy conservation workshops for small businesses.

Specific discussion and analyses were pursued by the group, leading to the recommendations and conclusions noted in that section.

Final Session and Closing Remarks

The two groups reconvened and each group chairman reported the results of his group's discussion. Specific recommendations and conclusions which had been postulated by each group were analyzed by the entire workshop; the final results, which are listed in the Conclusions and Recommendations Section, represent consensus views.

On behalf of the Department of Energy, Mr. Dominic J. Monetta provided the closing remarks. He indicated that the Department of Energy viewed this series of workshops as an experiment. The experiment was one of informal exchange and the parameters to observe are the dynamics. The experiment seems to have been successful since participants were active and the process seems to be working. He went on to point out the productivity of the workshop is measured by the process; the process of interaction is the product. The Department of Energy's hope for the outcome of these conferences is that leadership institutions will arise to articulate the needs for training. The Department of Energy and other federal agencies cannot provide the primary leadership. The collection of community colleges should coordinate and press for what they want. The Department of Energy can and will assist.

Mr. Monetta also suggested that each of the institutional representatives "look into his own house." What are the problems within each of their facilities? What is being done within each of their facilities to conserve energy and increase the awareness of energy conservation opportunities? Leadership is needed.

Mr. Monetta noted that one of the results of the conference should be an informal infrastructure brought about by the personal contact of meeting together for two days. He expressed his thanks to the participants of the meeting and expressed particular appreciation for their willingness to deal with the uncertainty brought about by deliberately not seeking closure in the workshop. He promised to have concise, readable proceedings published within four months.

APPENDIX A

WORKSHOP PARTICIPANTS

DEPARTMENT OF ENERGY/DIVISION OF POWER SYSTEMS

ENERGY CONSERVATION WORKSHOP

TRAINING REQUIREMENTS FOR TECHNICIANS

October 30 - November 1, 1977
Regency-Hyatt House, Atlanta

List of Participants

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APPENDIX B

DEPARTMENT OF ENERGY'S DIVISION OF POWER SYSTEMS

DEPARTMENT OF ENERGY'S DIVISION OF POWER SYSTEMS

When the Department of Energy (DOE) was recently reorganized, one of its major divisions became the Division of Power Systems (DPS). The primary objective of DPS is aimed at managing a transition away from the consumption of limited supplies of oil and natural gas. This goal is being pursued through research, development, and demonstration (RD&D) of technologies which will conserve supplies by more efficient use of petroleum and natural gas and by the use of alternative fuels. This program will conserve limited supplies of oil and gas in the near-term (1985) and mid-term (2000) time frames so as to provide sufficient time for development and commercialization of new supply technologies.

The overall conservation activity is aimed at technology development to promote conservation in all end-use sectors. The federal role in this effort rests on the necessity to develop and demonstrate technically and economically feasible conservation technologies which will achieve total energy savings goals with a minimum of economic disruption and environmental degradation. Successful program implementation will directly support the overall conservation research and development goal to reduce total U.S. energy consumption during the period 1975-2000 by at least 350 quads.*

In order to achieve these conservation goals, an integrated approach based on legislation and regulations to mandate conversion efficiencies and fuel usage patterns, voluntary improvements in energy efficiency induced through federal, state and local economic incentives such as taxes and credits, market-place forces, and federally sponsored RD&D is required. Although the first three approaches apply to all end-use sectors, they will not, in and of themselves, improve

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* A quad is one quadrillion (10^{15}) BTU's (British Thermal Units).

the efficient use of oil and natural gas quickly enough to avoid the severe economic and social dislocations that will occur with the projected energy supply/demand gap. Federally funded RD&D is needed to accelerate the development of those advanced energy conversion technologies that face significant economic, technical, and institutional barriers in order to meet National Energy Plan (NEP) and Market-Oriented Project Priority Study (MOPPS) goals for each of the energy end-use sectors. The technologies being pursued within this program element support potential end-use applications which face significant economic barriers to implementation and have been identified as NEP and MOPPS priority programs. A major program in Improved Conversion Efficiency has been established to achieve these goals.

Currently, this program consists of thirty-two projects managed within the Division of Power Systems. These projects comprise a diverse set of efforts to support different Department of Energy organizational elements in developing and demonstrating the commercial viability of advanced energy conversion technologies for application in the electric utilities, transportation, industrial, and residential/commercial sectors. These projects involve RD&D of technologies that support MOPPS/NEP objectives related to industrial waste heat utilization, cogeneration, fuel cells, waste heat recovery from federally owned facilities, building design and structures, and improved industrial process efficiency.

The general objectives are (1) to improve the efficiency of energy conversion processes (e.g., chemical to electrical, thermal to mechanical, chemical to thermal); and (2) to develop advanced conversion processes and systems that use fuels other than oil and natural gas. Specific objectives include the following:

- Develop technology to improve the efficiency of base-load electricity generation from 34 percent to 50 percent;

- Improve small power generator efficiency from 30 percent to 45 percent;
- Develop advanced internal combustion engines with efficiencies ranging from 25 percent to 50 percent (current range is 15-35 percent);
- Develop multifuel-capable fuel cells for electricity generation to save 0.5 quad/year by 1985;
- Develop technologies capable of using industrial waste heat at a rate of 0.8 quad/year by 1985;
- Develop advanced cogeneration technology using alternate fuels;
- Develop advanced insulation materials capable of saving 3.8 quads/year by 1985 through industrial and commercial/residential applications; and
- Develop technology in the areas of combustion, high-temperature materials, thermodynamics, heat exchangers, lubrication, and aerodynamic and rolling losses that are critical to achieving the national objectives required by the end users.

To achieve these energy savings and efficiency improvement objectives, specific technology-development efforts will be undertaken in three major thrust areas:

- Combustion Systems: to develop and demonstrate advanced technologies for increasing the efficiency and expanding the multifuel capability of heat engines and combustion devices for all end-use applications.
- Heat Engines and Heat Recovery: to develop and demonstrate advanced systems for energy conservation through the recovery and utilization of waste heat and through cogeneration.
- Fuel Cells: to commercialize state-of-the-art fuel cell technology for electric power generation and total energy systems in the near-term, and to develop and demonstrate advanced, higher efficiency, economically competitive fuel cell technologies.

The projects within each of these major thrusts have been selected and designed to maximize the contribution of the Improved Conversion Efficiency Subprogram to overall Department of Energy conservation goals. Table 1 shows the potential energy savings resulting from implementation of improved conversion efficiency technology projected by MOPPS. The total maximum potential savings in 1985 and 2000, respectively, reach 7.7 and 25.9 quads per year. These savings represent theoretical maximums assuming that limiting factors such as technical risks, barriers to market penetration, and funding limitations are overcome. However, the projections show that the Subprogram's major thrusts support end-use applications that can make a significant contribution to overall conservation goals.

Table 1. Estimates of Potential Improved Conversion Efficiency Energy Savings

End-Use Sector	Projected Energy Savings* (Quads/Year) 1985	2000
1. Industrial	4.7	12.5
2. Transportation	1.2	8.1
3. Residential/ Commercial	1.8	5.3
TOTAL	7.7	25.9

* Includes savings from energy efficiency technologies in the electric utility sector.

Activity in the heat cycles and combustion areas consists of two related areas - improved heat engines/cycles and advanced combustion and fuels technology. In the area of improved heat engines/cycles, technical efforts in the period FY 1978-82 will focus on the development and prototype evaluation of a number of advanced heat engine/heat cycle concepts. These efforts include an advanced component 10 MW industrial gas turbine, advanced heavy fuel utility turbines, diesel engines using high temperature ceramic components, Lysholm expander, stationary Stirling engines, external combustion Brayton cycle, dual fluid cycle for existing gas turbine engines, and tribology studies.

In the second area, for the period FY 1978-82, technology assessments and improved efficiency designs for intermittent combustion engines, continuous combustion engines, industrial/residential boilers and furnaces, and industrial process heaters will be developed. In parallel with these system development efforts, development studies will proceed in such related technologies as alternative fuels utilization; fuel processing, transport, and storage; and methane conservation.

Major activities during FY 1978 include:

- Open Cycle Brayton: Initiate the development and prototype fabrication of the heavy fuel combustion turbine; commence test program for dual fluid cycle gas turbines and 70 KW prototype Lysholm expander.
- Intermittent Combustion Engine: Complete experimental program leading to design and development of a direct injected stratified charge automotive engine capable of utilizing alternative fuels.
- External Combustion Engines: Complete technology studies of large Stirling engines for stationary applications leading to decision to develop prototype; initiate laboratory test program of externally-fired Brayton engine for advanced cogeneration applications.
- High Temperature Materials: Complete fabrication and testing of advanced gas turbine ceramic components for

electric power generation; initiate laboratory demonstration of hot pressing and pressureless sintering ceramic fabrication techniques.

- Tribology: Complete preliminary designs of advanced automotive engine pistons and rings.
- Fluid Mechanics: Conduct demonstrations of several potential de-scaling applications of the cavitating hydrojet.

Acitivity in the waste heat utilization area focuses on development and demonstration of waste heat utilization technologies including recovery of waste heat at Department of Energy gaseous diffusion plants, organic Rankine bottoming cycle systems, thermionic topping cycle systems, fluidized beds and ceramic heat pipes for heat exchangers, advanced insulation materials for space heating and cooling, and advanced cogeneration concepts. In addition, applied research activities include fluid mechanics studies of automobile aerodynamic drag, building heat loss from winds, and identification of improved methods for nitrates production and water purification.

Major activities during FY 1978 include:

- High Grade Heat Utilization: Initiate prototype development of two alternative first generation thermionic conversion topping cycle systems; conduct test programs of advanced ceramic and alloy components for thermionics applications.
- Middle Grade Heat Utilization: Complete evaluation test of 500 KW prototype binary Rankine bottoming cycle system and commence evaluation test of 600 KW prototype organic Rankine bottoming cycle system to verify system performance and reliability characteristics and to demonstrate multiend-use sector application potential.
- Low Grade Heat Utilization: Complete feasibility studies and implementation plans for waste heat

recovery at Department of Energy owned facilities and make decision to proceed with recovery program. Concurrently, initiate the development of low temperature heat systems and enhanced low temperature component technology.

- Cogeneration: Initiate comprehensive cooperative government-industry study program to identify and evaluate alternative advanced concepts in cogeneration technology.
- Advanced Heat Exchangers: Complete evaluation of fluidized bed waste heat recovery unit.

Activity in the fuel cell area will enter the demonstration phase with the completion and installation of a 4.8 MW module at a host utility. In parallel with this effort, first generation systems development work will continue in the area of phosphoric acid fuel cells. For second generation technology, development of cell tile and stack technology will continue in the molten carbonate fuel cell area, leading to initial testing in FY 1979. Applied research efforts will continue in solid oxide fuel cell systems and an alkaline fuel cell system will be re-evaluated.

In the FY 1980-82 time frame, the emphasis will be on development of higher performance, lower cost systems with multifuel applications. Systems capable of utilizing coal, waste hydrogen, methanol, and other coal-derived fuels will be developed for application to cogeneration and electrical base and peak load power generation. Future activities include exploration of advanced vehicular concepts and hybrid fuel cell systems.

Major activities in FY 1978 include:

- Utility Demonstrations: Complete fabrication of the 4.8 MW demonstration unit; initiate 4.8 MW demonstration installation in host utility.
- First Generation Systems Development: Initiate development efforts on low-cost cell stack fabrication

process; initiate fabrication and demonstration program for fuel cell powered total energy systems; initiate fuel cell transportation applications program.

- Second Generation Technology: Complete molten carbonate fuel cell/coal gasification interface study; complete preliminary systems design studies; develop scaled-up cost-effective hardware; identify sulfur-tolerant cell materials.
- Fuels Utilization: Initiate experimental evaluation of hydro-processing schemes for heavy residual hydrocarbon fuels; initiate auto-thermal reforming of heavy fuels assessment.
- Applied Research: Complete re-evaluation of alkaline fuel cell system; initiate combination unit and cell stack useful life testing of solid oxide electrolyte fuel cell; initiate development effort on trifluoromethanesulfonic acid (TFMSA) for potential transportation applications.

In FY 1978, DPS has slightly over $61 million to spend. It works closely with five national laboratories (Argonne, Brookhaven, Lawrence Livermore, Los Alamos, Sandia) and contracts with private industry and universities for much of its work.

The following briefing charts summarize the mission, objectives, and programs of DPS (DPS incorporates the activities that were the responsibility of the Division of Conservation Research and Technology before the formation of the Department of Energy).

Division of Power Systems

Program Summary

Mission

Allow a Smooth Transition

From Oil and Gas to Alternate

Fuels in Energy Conversion

Equipment

- Efficiency
- Fuel Flexibility

Objectives

- Baseload Power Generation at 45-50%
  - — Reduced Cost of Electricity
  - — Increased Environmental Standards
- Small Scale Power Generation Technologies
  - — Multi-Fuel/Efficient
  - — Cogeneration
- Heat Recovery Technologies

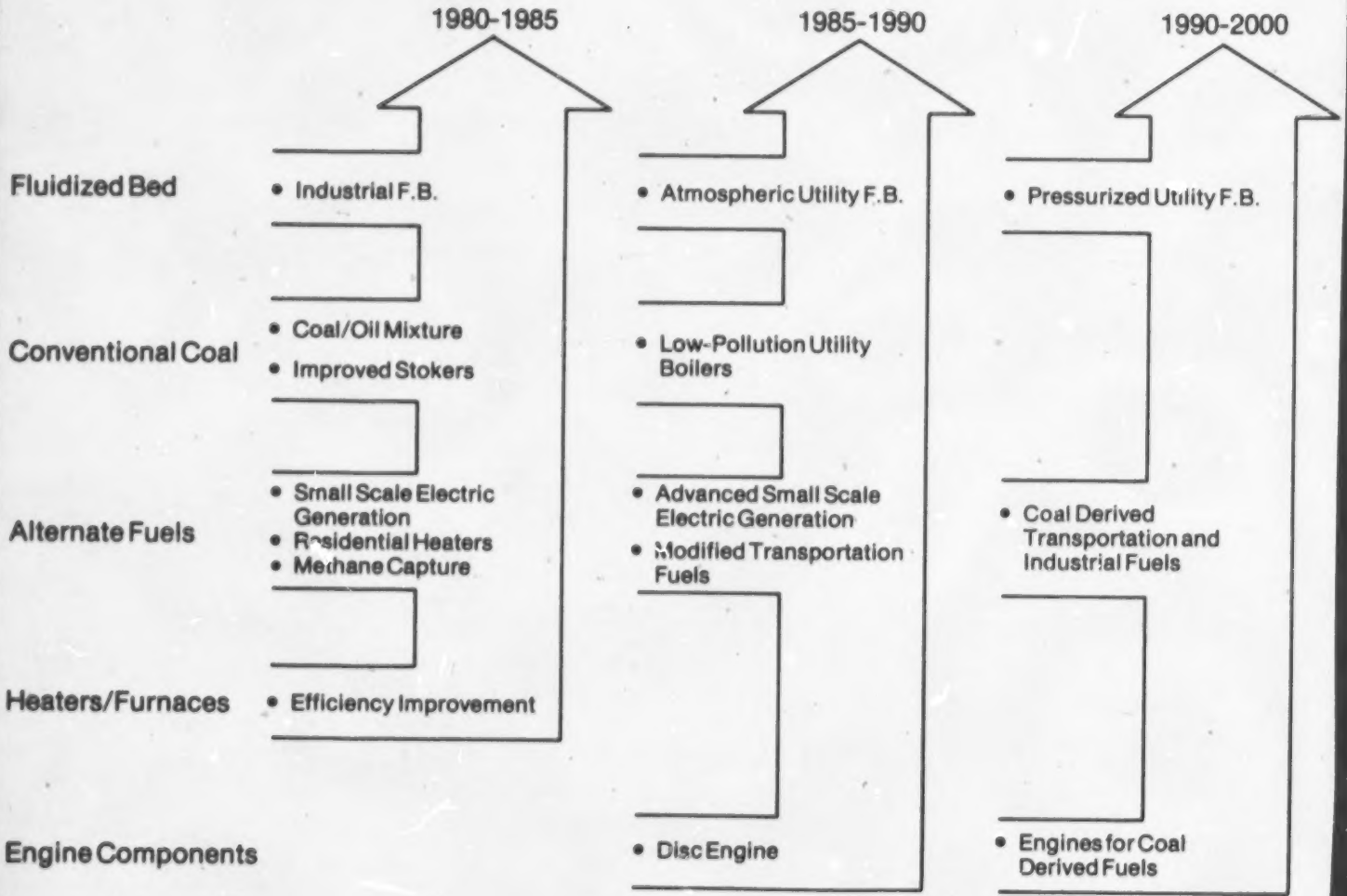
Major Programs

- Combustion Systems
  - — Fluidized Beds
  - — Burners/Boilers
- Heat Engines and Heat Recovery
  - — Gas Turbines
  - — Advanced Cycles
  - — Organic Rankine Cycles
- Fuel Cells
  - — Phosphoric Acid
  - — Molten Carbonate

Combustion Systems Objectives

- Coal and Alternate Fuel Utilization
  - — Fluidized-Bed Combustion of Coal
  - — Improved Conventional Combustion of Coal
  - — Combustion of Alternate Fuels
- Combustion Equipment Efficiency Improvement
  - — Space Heaters and Industrial Furnaces
  - — Engine Combustion Components

Combustion Systems Timing



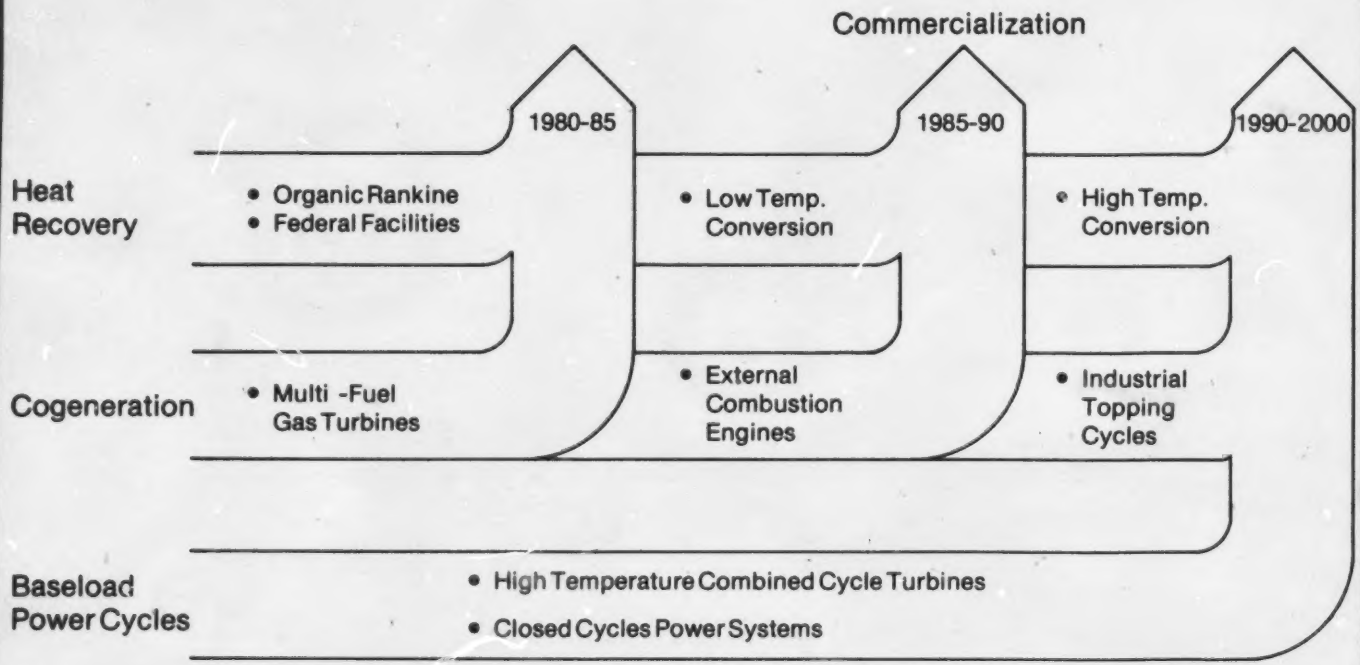
Heat Engines and Heat Recovery Objectives

- Develop High Efficiency Engine Cycles for Intermediate and Baseload Utility Power Generation
  — 45-50% Efficiency
  — Direct Utilization of Coal

- Develop Advanced Cogeneration Technologies for More Efficient Fuel Utilization in the Industrial and Residential/ Comercial Sector
  — Fuel Flexible
  —Adaptable to Synthetic Liquid Fuels

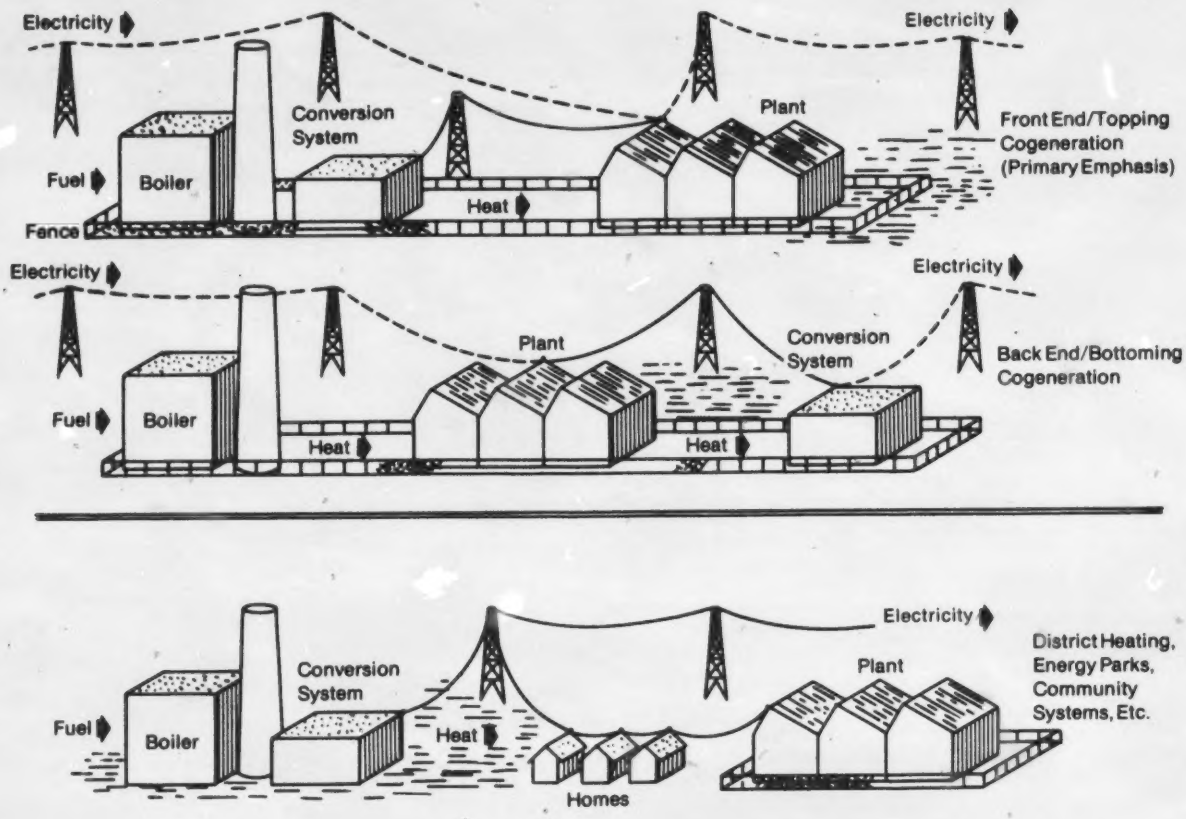
- Develop Technology to Allow Cost Effective Recovery of Reject Heat in the Utility, Industrial, and Residential/ Commercial Applications

Heat Engines and Heat Recovery Program Timing



Cogeneration Options

Included in CTAS

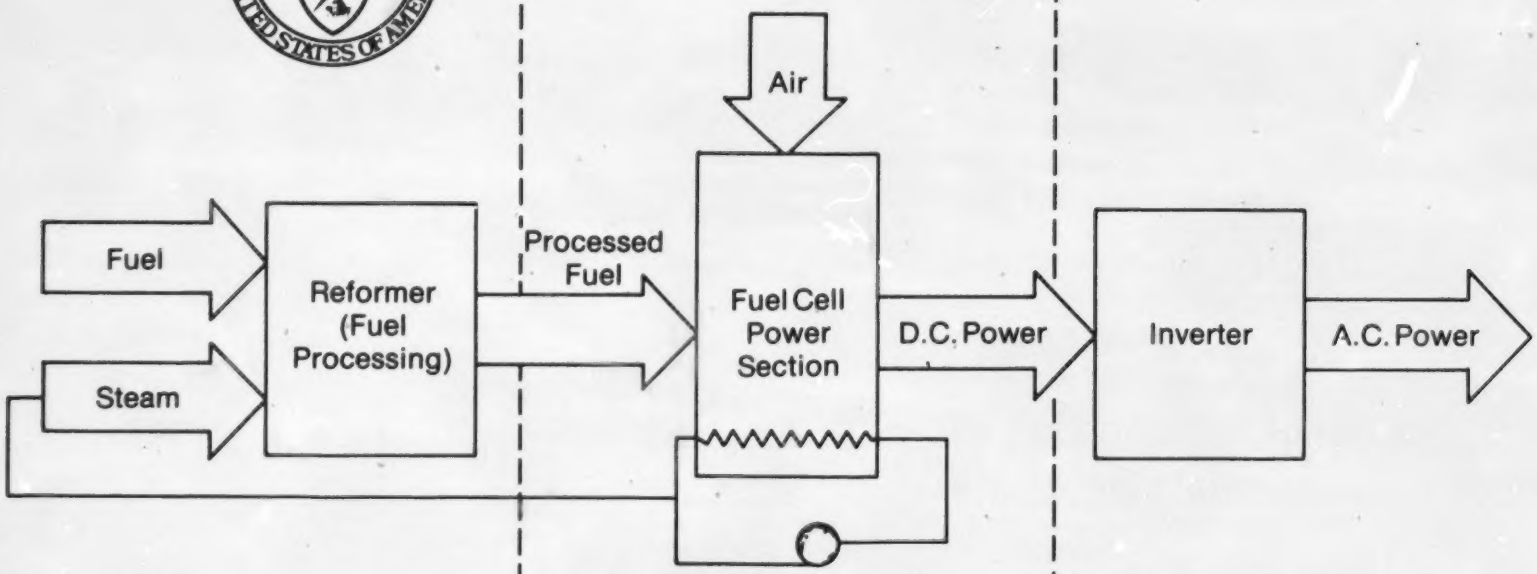


Fuel Cell Program Objective

To Develop Fuel Cell Powerplants for:

- Electric Power Generation
  - — Peaking (Near Term)
  - — Intermediate (Near Term)
  - — Base Load (Long Term)
- Co-Generation
- Building Total Energy
- Waste Conversion
- Transportation

THE FUEL CELL POWER PLANT
FUEL TO ELECTRIC POWER



1 The Reformer Section Processes Fuel for Fuel Cell Use

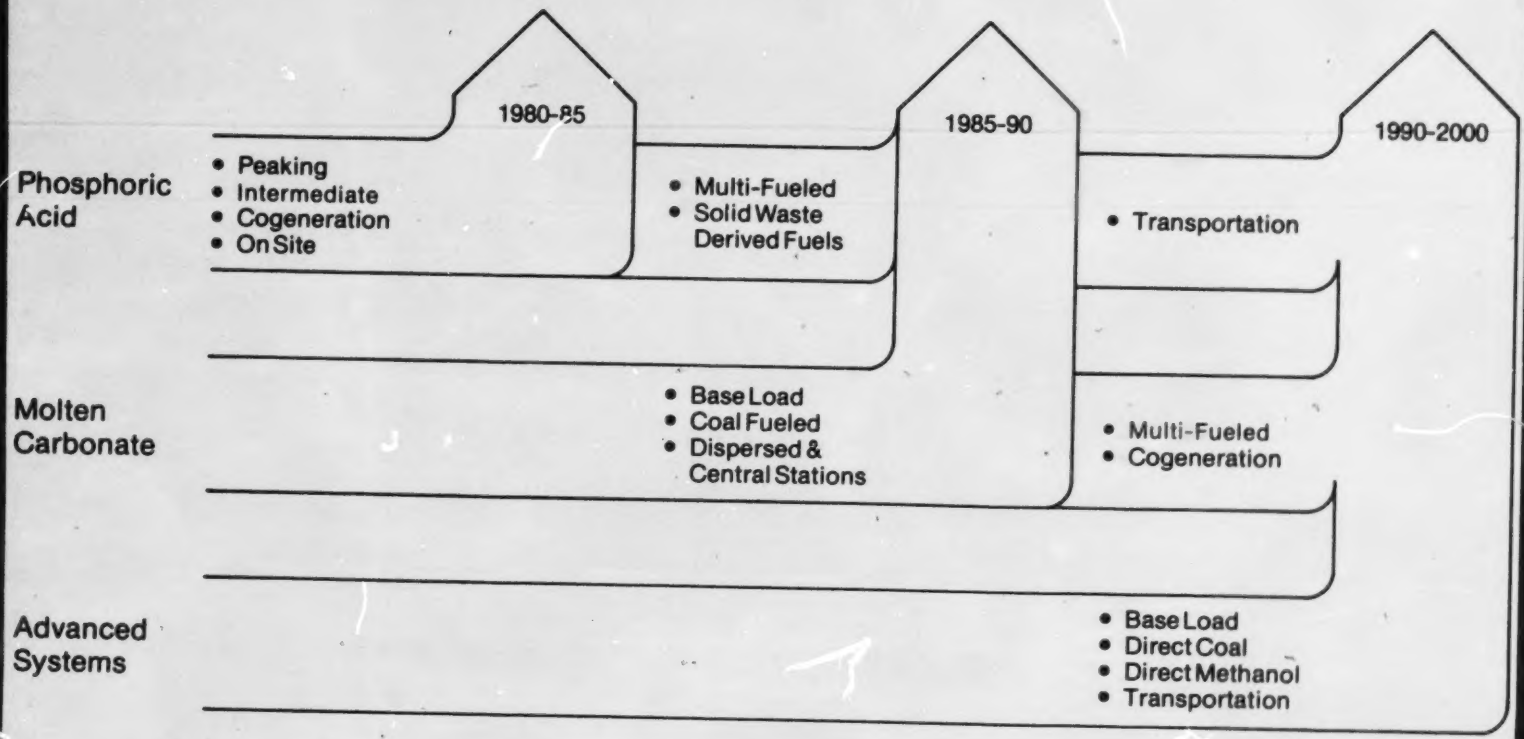
2 The Power Section Converts Processed Fuel and Air Into D.C. Power

3 The Inverter Processes Useable A.C. Power to Meet Customer Requirements

FUEL CELL POWERPLANT CHARACTERISTICS

- VERY EFFICIENT
  - IN SMALL SIZES
  - AT PART POWER
- MODULAR
- A GOOD NEIGHBOR
  - QUIET
  - LOW EMISSIONS
- WASTE HEAT RECOVERABLE
- USES ALL FUELS

FUEL CELL SYSTEMS PROGRAM TIMING



APPENDIX C

THE COMMUNITY COLLEGE SYSTEM

THE COMMUNITY COLLEGE SYSTEM

One of the strongest educational phenomena since the turn of the century has been the rapid and impressive growth of the American community college system. The current concept started in the 1940's in California and accelerated after World War II because of a large influx of veterans, increasing educational costs, and the limited accessibility of the college and university systems that then existed. What has developed has been a series of "community-based" colleges offering the first two years of post-secondary education and usually granting an Associate Degree with primary focus on low cost, accessibility (by being located in the communities and being basically "commuting colleges"), strong emphasis on quick and innovative responses to local educational needs, and the exercise of an "open door" admissions policy (in which any person in the community with a high school diploma might attempt to achieve his low-risk educational goals).

These elements would have been enough to make the community college movement grow, but added to this was the upsurge in the needs of industry and the public sector for an ever increasing number of technicians and technologists. Basically, these are persons with training needs beyond high school but less than those requiring a Bachelor's degree. There have been literally thousands of these types of jobs for which training opportunities have opened over the past two decades. One of the leading fields has been Allied Health with programs in such specialties as licensed practical nurses, registered nurses, dental hygienists, and operating room technicians. The scientific and technical fields also have been involved with numerous programs in such areas as mechanical engineering technology, chemical engineering technology, engineering aid, environmental technologists, etc. All have been effected by this expansion, and programs have

emerged in such areas as law enforcement, business management, agriculture, social science, and the humanities.

Another dimension of the community college field which has brought an impressive number of students to their campuses has been the ability of the community colleges to respond, through continuing education, to a variety of training needs for the adults of the community. This usually extends through a variety of options, all the way from one-night lectures to concentrated two-month certification programs down to a wide catalog of specialized training programs of varied length and complexity.

Piggy-backing on this diversity as well as on the availability of community facilities have been a variety of community service programs. These have often had purposes which are not "educational" in the formal sense and have included lectures, film series, or simply the use of the community college facilities for public hearings and meetings of special community interest groups. This utilization of the community college for a wide variety and scope of community service "needs" provides the system with a unique political base from which potential strengths can be realized. A general description of the characteristics of the Community College System is discussed in the following paragraphs.

Institutions

According to information collected in October 1976, there are approximately 1,230 two-year institutions in the United States and outlying areas. Among these are public and independent community and junior colleges, separate campuses of individual colleges, technical institutes, and two-year branch campuses of four-year colleges and universities. Located in urban, rural, and suburban areas, these institutions can be found in every state in the U.S. as well as in the District of Columbia, Puerto Rico, the Canal Zone,

American Samoa, Canada, and in various other foreign countries. Within the United States there is at least one community college in 426 of the 435 Congressional districts.

Enrollment

Opening fall enrollment figures for 1976 showed that a total of 4,084,976 students (both full-time and part-time) were enrolled in two-year institutions for credit courses. This represented 35 percent of the total undergraduate enrollment in this country. Over half (52 percent) of all students enrolled in postsecondary institutions for the first time were enrolled in two-year colleges.

Students

Women made up 48 percent of the total headcount enrollment and 50 percent of the part-time headcount enrollment in community and junior colleges. Minority student enrollment was estimated at between 15 and 20 percent of the full-time enrollment at two-year colleges, according to the Office for Civil Rights. Data from the Bureau of Census show that in 1975, 52 percent of the students in two-year colleges were over age 21.

Data describing characteristics of students illustrate some important differences between those attending two-year and those attending four-year colleges. For example, 75 percent of the students delaying college entrance at least 5 years after high school graduation, enroll in two-year rather than four-year colleges. Over half of the students attending two-year colleges are over age 21; several community and junior colleges report that the average age of their enrolled students is approximately 30.

National norms for full-time freshmen entering two-year colleges in 1976 show that about one-third of these students, as compared with about one-half of students entering four-year

colleges, receive support of $500.00 or more from parents or family. Nearly one-fifth of the men but only about 10 percent of the women entering two-year colleges receive support from part-time employment. Slightly over one-quarter (27 percent) of these first-time, full-time freshmen in two-year colleges are from families with incomes of less than $10,000.

More students in two-year colleges are older, married, from less affluent homes with parents who have less education, and are attending part-time than students from four-year colleges and universities. Among two-year college students, 30 percent are married and living with their spouses, twice the proportion among those in four-year colleges who are married.

Students from minority groups comprise close to one-fifth (17 percent) of the first-time freshmen in two-year colleges. The number of black students enrolled both full-time and part-time in all postsecondary institutions has increased by 80 percent from 1970 to 1975. Data also indicate that the proportion of black high school graduates entering college is about equal to that of Caucasian students (50 percent).

Between 1975 and 1976, according to data from the National Center for Education Statistics, the number of women enrolled in two-year colleges increased by 6 percent while the number of men decreased by 6 percent. Part-time enrollments also continue to increase at two-year colleges; in the fall of 1976, 75 percent of all students attending were enrolled part-time.

Data on college enrollments from the National Longitudinal Study of the High School Class of 1972 reveal that 60 percent of the students initially entering two-year institutions either had completed a course of study, transferred to a four-year institution, or were still enrolled in 1974. Three out of four first-time, full-time students at two-year

colleges cited "ability to get a better job" as a primary reason for attending college; 25 percent of these students who enrolled at a two-year college selected their college because of low tuition rates.

Although information on associate degree recipients was not reported, Census Bureau data for male full-time workers, aged 25, revealed that the expected lifetime income for those with one to three years of college was about 20 percent higher in 1972 than for those with four years of high school. Similarly, the unemployment rate of workers in 1976 indicated that in the 18-24 age group, about 9 percent of those with 1 to 3 years of college were unemployed while 15 percent of those in the same age group with only 4 years of high school were unemployed.

As of October 1975, according to the same source, approximately 1 out of 5 high school seniors either planned to attend a two-year college or planned to attend both a two-year and a four-year college. Over two-thirds of the first-time, full-time freshmen at two-year colleges planned to obtain a bachelor's degree.

A survey from the National Center for Education Statistics indicated that a total of over 27 million people participated in adult education programs during the course of a year, as of May 1975. Over half (52 percent) of these adults were participating in noncredit courses. Of the remaining group which was enrolled for credit courses, only 25 percent were actually working toward a degree.

Faculty and Administration

In order to serve the diverse group of students enrolled in two-year institutions, a reported 199,691 faculty members and 15,633 administrators were employed for the 1976-77 academic year, as of October 1976. In addition, 13,180 other professionals, including librarians and counselors, were reported to be employed. Three out of four of the faculty

in two-year colleges have the master's degree or above.

Tuition and Fees

While rates vary from college to college or from state to state, two-year college tuition remains generally low. Average charges for tuition and required fees were approximately $332.00 per year for public colleges as of October 1976 for the current year. At independent or private two-year colleges, the average for the current year is $1,645.00. These averages represent increases of less than 5 percent for public colleges and less than 10 percent for private colleges as compared with the previous year.

Programs

Community, junior, and technical colleges offer a variety of programs designed to meet the needs of many kinds of students. A National Center for Education Statistics report estimates that over 1,300 different occupational programs are offered by these institutions. As well as occupational and liberal arts programs leading to the associate degree, these institutions also provide short-term training courses leading to specialized certificates and diplomas. In most two-year colleges, responsiveness to the community is provided through a multitude of noncredit courses. Several innovative methods are used in community and junior college programs, among which are credit by examination, cooperative education, volunteer service programs, individualized instruction, and multimedia instruction.

Vocational/Occupational/Technical. This category of programs includes training in such fields as data processing technologies; health services and paramedical technologies such as dental hygiene and medical records; engineering technologies, including automotive, diesel and welding programs; business and commerce technologies, including restaurant

management, accounting, and communication; and public service technologies such as recreation and social work, police and fire science programs. These programs are designed to lead directly to employment in a specific established or emerging field, terminating with a certificate, diploma, or associate degree.

Transfer/Liberal Arts/College Parallel. These programs are designed for students who plan to continue their post-secondary education at a four-year college or university. The programs are comparable to the first two years of a baccalaureate degree program and usually terminate in the associate degree.

Community Education and Special Interest Programs. Other major programs are offered for those students or community members interested in civic, cultural, or recreational courses not carrying academic credit toward a degree, diploma, or certificate. Specific programs are also designed for such groups as women returning to school, labor union members, senior citizens, and those seeking job upgrading skills. Developmental and remedial programs, most often in communication skills, are also offered at two-year colleges.

During the 1960's, enrollment in occupational programs began to grow, largely because more new programs were begun and because enrollments in all programs were increasing. An American Association of Community and Junior Colleges (AACJC) survey in 1965 showed that about 13 percent of the total number of two-year college students were enrolled in an occupational program. By 1970, approximately 30 percent of the students at two-year colleges were taking courses in occupational areas. It has been estimated that these colleges now offer as many as 1,400 different types of programs in this area and that enrollment in 1977-78 will approach 45 percent.

Information provided through discussions with those at two-year colleges indicates that enrollment in occupational programs now accounts for about half of the total enrollment,

or 2 million students. Enrollment in occupational/vocational programs offered at the postsecondary level in all types of public institutions has increased from 207,201 in 1965 to 1,889,946 in 1975 according to data from the U.S. Office of Education. Although enrollment in occupational programs is increasing, in many two-year colleges the humanities and general education are enjoying renewed interest through such specially designed programs as courses by newspaper, educational television courses, and interdisciplinary programs.

* U. S. GOVERNMENT PRINTING OFFICE : 1978 261-325/505